Riyadh Metro Project

Tunnel Boring Machine (TBM)
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Introduction

- Riyadh Metro Project is the present and future work experience as a new megaproject in Saudi Arabia.
- It consists of 6 lines integrated to each other by 4 Main Stations.
- A total length of 176 km linked with 85 stations
Metro Lines

- Line 1: “Olaya Street” 38 km
- Line 2: “King Abdullah Road” 25.3 km
- Line 3: “Almadinah Road” 40.7 km
- Line 4: “King Khalid Airport” 29.6 km
- Line 5: “King Abdulaziz Road” 12.9 km
- Line 6: “Abdulrahman bin Awf” 30 km
Underground Trains

<table>
<thead>
<tr>
<th>Length (km)</th>
<th>Total Length</th>
<th>Tunnel</th>
<th>At Grade</th>
<th>Elevated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line 1</td>
<td>38</td>
<td>17.3</td>
<td>4.8</td>
<td>15.9</td>
</tr>
<tr>
<td>Line 2</td>
<td>25.3</td>
<td>3.3</td>
<td>16.6</td>
<td>5.4</td>
</tr>
<tr>
<td>Line 3</td>
<td>40.7</td>
<td>9.4</td>
<td>5.2</td>
<td>26.1</td>
</tr>
<tr>
<td>Line 4</td>
<td>29.6</td>
<td>5.9</td>
<td>6.9</td>
<td>16.7</td>
</tr>
<tr>
<td>Line 5</td>
<td>12.9</td>
<td>12.9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Line 6</td>
<td>30</td>
<td>8</td>
<td>2</td>
<td>19.7</td>
</tr>
</tbody>
</table>

Line 1 has the tallest tunneling path
Line 1

- At Grade
- Elevated
- Underground
Line 1 Contractors

- “BACS” CONSORTIUM
  - Bechtel
  - Almabani
  - CCC
  - Siemens

- The contract is “Design and Build” contract
Project Time Schedule

OVERALL SCHEDULE

- Contract Award
- Start Construction
- Design & Long-lead Procurement
- 48 Months Core Construction
- Test & Commission
- 8-month LD Holiday

60 Months Overall Program
Time Chainage Diagram
Stations

• Line 1 is connecting 3 Main stations and has 22 Pick-Up stations.
• The main stations are:
  • 1- King Abdullah Financial District Station
  • 2- Olaya Station
  • 3- Qaser Al Hokm Station

• One Example of the Pick-Up stations is 1A2 “shown in figure”
Olaya Station

- **Location**: South of King Abdullah road at the intersection of Line 1 Olaya-Batha with Line 2 King Abdullah road.

- **Area**: 11,000 m².

- **Designer**: Gerber Architekten (Germany).
1A2 EXISTING CONDITIONS
1A2 EXISTING CONDITIONS
1A2 DEEP UNDERGROUND STATION-OPTION 1
1A2 DEEP UNDERGROUND STATION OPTION 2
Shopping Street
TBM Launching Shafts

TOTAL DIST.

3947m

4155m

5125m

3250m

BLUE TBM

ORANGE TBM

BROWN TBM

PURPLE TBM

DRIVE NORTH FROM LAUNCH SHAFT SOUTH OF 1B3 INTO RECEPTION SHAFT SOUTH OF 1A2

DRIVE SOUTH FROM LAUNCH SHAFT SOUTH OF 1B3 INTO RECEPTION SHAFT NORTH OF 1C4

DRIVE NORTH FROM LAUNCH SHAFT BETWEEN 1F2 & 1F4 INTO RECEPTION SHAFT SOUTH OF 1C4

DRIVE SOUTH FROM LAUNCH SHAFT BETWEEN 1F2 & 1F4 INTO RECEPTION SHAFT NORTH OF 1F8
EXISTING CONDITIONS
TBM General Information

• The excavation depth in Line 1 starts from 11 m and reaches a maximum of 36 m depth at the segment between (1B1-1B2).
• Design life of TBM Bored tunnel is 100 years.
• Design fire resistance is 3 hours.
Geotechnical Design Consideration

- In almost half of the route of Line 1 competent limestone with limited weathering and without groundwater table is expected.
- From station “1F2” to “1F4” in line 1, TBM cross a silty clayey sand layer.
- Typically settlements over the tunnel (0-10mm).
- Some areas of greater predicted settlement (10-30mm) in the southern section of the Line 1 tunnel, near Station “1F2”.
Geometry of TBM

- The tunnel internal diameter is 9.0m
- This diameter is further increased by 0.2 meter to accommodate TBM construction tolerance as required.
- The proposed TBM final lining is precast segments of 360mm thick.

<table>
<thead>
<tr>
<th>Lining Thickness (mm)</th>
<th>360</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal diameter (mm)</td>
<td>9200</td>
</tr>
<tr>
<td>External diameter (mm)</td>
<td>9920</td>
</tr>
</tbody>
</table>
Soil Excavation Quantity

- In a simple calculation, we can assume the quantity of soil to be excavated.

- Area of tunneling = 77.29 m²
- Tunneling Length = 17.3 km

- Soil Volume = 17300 * 77.29 = 1337117 m³
Thank you